

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 38. FEBRUARY 1871.

IX.—*Description of a considerable portion of a Mandibular Ramus of Anthracosaurus Russellii*; with Notes on *Loxomma* and *Archichthys*. By ALBANY HANCOCK, F.L.S., and THOMAS ATTHEY.

[Plate VI.]

IN 1862 Professor Huxley made known the presence in the Lanarkshire coal-field of a large and powerful Labyrinthodont, to which he gave the name of *Anthracosaurus Russellii**. This species was founded on a nearly perfect cranium; and at the same time a vertebra and a rib supposed to belong to this Amphibian were also described. No further evidence of the existence of this formidable creature of the Carboniferous era was procured till Mr. Atthey obtained a large portion of another cranium belonging to it at Newsham. This interesting fragment was described, in the September Number of the 'Annals,' in 1869; and we gave in the same paper an account of the anterior extremity of a mandibular ramus and of a large sternal plate, which we believed likewise to belong to *Anthracosaurus*.

We are not aware that any further account has appeared of the occurrence of remains of this rare Amphibian. It is therefore with much pleasure that we are enabled, through the kindness of Mr. Ward of Longton, to describe a large fragment of a mandible belonging to this species. This specimen forms part of that gentleman's well-known collection, and is from the new ironstone shale of Fenton. It is a portion of the posterior extremity; but the articular process is wanting. The fragment is 7 inches long, and measures nearly 4 inches from the alveolar border (Pl. VI. *a*) to the inferior margin (*b*). There is just two inches of this margin perfect; and this is at the point where undoubtedly the ramus is deepest. The inner

* Quarterly Journal of the Geological Society, vol. xix. p. 56.

surface is exposed to view, and is concave longitudinally, the outer surface being a little convex, as is evident in the transverse section of the specimen in front. The bone, which is in a very perfect state of preservation, is composed of two parallel layers—an inner, the splenial plate (*c*), and an outer, the dentary piece (*d*)—and is stout, particularly at the alveolar border, where it is an inch thick; thence it becomes gradually thinner to the longitudinal middle line; here it is scarcely more than $\frac{1}{4}$ of an inch thick, and so continues to the inferior margin.

The upper surface of the alveolar border is slightly channelled, and is almost straight; but within $3\frac{1}{4}$ inches of the posterior extremity it is bent a little downwards (*e*), and then, rising up considerably above the level of the border, is continued backwards in a straight line (*f*) to the posterior extremity; this straight part is $1\frac{1}{2}$ inch long, and is bevelled off to a sharp edge. In front of the elevation the alveolar border has been torn, apparently by pressure, from the inner layer of bone, which at this part is pushed a little downwards.

The teeth are well preserved; in all there have been twelve, nine of which are almost perfect, and, with the exception of the three posterior ones, are all of the same size. They are nearly an inch long, and at the base are upwards of a quarter of an inch wide; they taper gradually to the apex, which is a little compressed in the direction of the long axis of the jaw, and in the same plane has the sides slightly carinated, and is also rather suddenly bent inwards and backwards; but the recurving is probably, in part at least, owing to pressure. The crown is not perfectly cylindrical or, rather, conical; it is a little flattened at the sides, and is therefore in cross section somewhat angulated; and at the base it is wider in the transverse than in the longitudinal direction of the jaw. The whole surface is covered with brilliant enamel, and is longitudinally grooved to within less than a third of the apex. The grooves are fine, rather distant, and the spaces between them are flattened, so that there is a tendency to a ridged appearance.

The teeth are clustered, and in this respect agree with those of the maxillæ. In the clusters the bases are in contact; and short spaces divide the clusters. The first tooth (*g*) is split longitudinally by the anterior fracture of the specimen, and very little of it remains: only a small piece of the base is perceptible; but a partial impression of the crown shows that it was as large as the others. The base of the second tooth is not far from that of the first, and is the first perfect one of the series. The third tooth has been removed for structural exami-

nation; it stood apart, about a quarter of an inch from the second, and as far from the fourth tooth. The fourth and fifth are in contact, and are separated from the sixth by about a quarter of an inch; the sixth, seventh, and eighth are close together, and form the largest cluster of the series. Then follows a space of upwards of a quarter of an inch, and the series is terminated by three teeth much smaller than the rest; these are clustered, the first two being almost perfect, and the third (*h*) having almost entirely disappeared. These three posterior teeth are placed just at the point where the alveolar border begins to rise, and are $2\frac{1}{2}$ inches from the hinder extremity of the specimen.

The mandible of *Anthracosaurus* is distinguished from that of *Loxomma*, the only known jaw with which it is likely to be confounded, not only by its greater size, but also by the massiveness of the bone. It is an inch deeper or wider than the largest mandible we have seen of the latter; and the bone is very much thicker. The form of the teeth likewise distinguishes this species from *Loxomma*: they have the crown much less compressed, and the trenchant margins are not nearly so much developed; towards the base, too, they are more cylindrical, or, rather, conical, though they are somewhat irregularly flattened and angulated at the sides. They are also much more uniformly of a size; in this respect they vary greatly in *Loxomma*, while we have seen that in the fragment before us the teeth are about the same length, with the exception of the three terminal ones of the series. The internal structure of the tooth is also characteristic, and at once distinguishes this species from *Loxomma*.

Indeed the characters of the teeth of *Anthracosaurus* are very peculiar; their thickness and angularity at the base, the delicate conical taper upwards, the incurving of the apex, its slight compression and the small development of the trenchant margins are the distinguishing features of this form, and at once enable us to determine the generic and specific identity of Mr. Ward's interesting fragment. But had any doubt existed, the internal structure of the tooth would have removed it. In all these characters this specimen exactly agrees with *Anthracosaurus Russellii*; the Labyrinthodont structure in particular accords in every respect with the very clear description given of it by Professor Huxley in the original memoir.

It is true that the teeth are stated to be ridged, while we have described them as grooved. This character, however, we pointed out, in our former paper on *Anthracosaurus* already quoted, varies according to the state of preservation of the

specimen. We have in our possession teeth of this species both ridged and grooved. They seem to vary in this respect even when perfectly fresh; but if a little eroded, the ridges are much exaggerated and become quite sharp, giving a very striking appearance to the tooth. In *Loxomma* the same variability obtains: the teeth of that form are usually grooved; some, however, are ridged, while in others the ridges are greatly increased by erosion.

There is in Mr. Atthey's collection a peculiar bone from the shale at Newsham, that has been a great puzzle to us for a long time. It was not till a nearly perfect mandibular ramus of *Loxomma* was obtained that its true nature was solved. It was then at once seen to be the articular piece, with a portion of the dentary bone attached, of some large Labyrinthodont. In form it closely resembles the same part in the ramus just alluded to; only it is very much larger, and must have belonged to a jaw equal in size to that from Fenton. In fact, from its dimensions and massive character, it would seem more than probable that this Newsham articular piece really belongs to *Anthracosaurus*.

The posterior margin of the fragment of the ramus in connexion with the articular piece is perfect, and sweeps downwards in an even curve, which, if continued a little further, as it appears to have been, would give to the posterior part of the jaw a depth of quite 4 inches—the measurement near the same point of Mr. Ward's specimen. The articular piece stands well up; the neck is short and stout; the process bearing the glenoid surface is massive, and is transversely elongated, measuring $2\frac{1}{4}$ inches long and an inch wide; the glenoid cavity is deep, and takes a slight sigmoid curve; behind at the outer margin there has been a stout projecting process; and in front towards the inner margin there has been a similar projection of the lip of the articular cavity. It would therefore seem evident that the attachment of the mandible to the tympanic trochlea must have been very firm, rendering the movements of the jaw secure and precise. Indeed the massive character of the whole articular piece indicates great power, and is well correlated with the huge vomerine tusks and formidable dentition of this species.

The presence of *Anthracosaurus* in the Newcastle coal-field does not rest merely on the occurrence of this articular piece. We have already alluded to a large portion of the cranium that was found at Newsham. This interesting specimen exhibits numerous maxillary teeth and the two great vomerine tusks so characteristic of this powerful Labyrinthodont. The anterior extremity of a mandibular ramus with five teeth at-

tached was also described in the same paper with the last-named specimen. And now we have to record from the same locality a fragmentary specimen of the middle portions of a pair of mandibular rami displaying several teeth. These fragments lie one over the other, and are much confused and mixed up with some other bones that are adherent by pressure to the general mass. The surfaces of the teeth, however, are in a very good state: some exhibit grooves, others ridges. In one of the teeth the grooves are very delicate, and are precisely like those in Mr. Ward's specimen.

Besides the above evidence of the occurrence of *Anthracosaurus* in the Newcastle coal-field, detached teeth are likewise found at Newsham, agreeing in every particular, externally and internally, with the type specimens. They are rare, however, in comparison with those of *Loxomma*, which is undoubtedly the much commoner fossil of the two.

Loxomma Allmanni, Huxley.

Since our paper appeared in the 'Annals' (May 1870) on the occurrence at Newsham of an imperfect cranium of *Loxomma Allmanni*, Mr. Atthey has obtained from the same locality another and complete cranium of this fine Labyrinthodont. This second example was procured about the middle of last June, and is one of the finest and most perfect specimens that have yet been found. Indeed, so far as we know, there are but two others that can at all be compared with it; and these are the beautiful skulls alluded to in the above paper as being in the possession of Mr. James Thomson, of Glasgow.

Our second specimen is 14 inches long and nearly $7\frac{3}{4}$ inches wide across the occipital region, where the skull is widest. We estimated the length of the first obtained specimen, which wants the muzzle, as 12 inches; but, as it is 9 inches wide, this estimate is probably considerably less than it ought to be. Since we have seen that the one which is only $7\frac{3}{4}$ inches wide is 14 inches long, we should certainly expect that the specimen measuring 9 inches across would be proportionately longer. The latter could scarcely have been less, when perfect, than 15 or 16 inches in length.

The specimen recently obtained has been entirely removed from the matrix, so that both the upper and under surfaces of the skull are completely exposed to view. The bone is in a very good state of preservation, and exhibits in great perfection, covering the whole of the upper aspect, the peculiar honeycombed or reticulated structure common to these Labyrinthodonts. The roof of the mouth is also well displayed, particularly the sphenoid and the vomerine and palatal bones,

likewise the posterior nares and the palato-temporal foramen. The basal portions of the teeth, too, are nearly all present; but the crowns, unfortunately, have disappeared.

In every respect the characters agree with those of the previously described specimen; and in addition, the parietal foramen is distinctly marked in the new example. This characteristic feature is not seen in either of Mr. Thomson's specimens; but in the original cranial fragment described by Professor Huxley it is well indicated on the inner surface*. In our specimen it is small and circular, measuring not much over an eighth of an inch in diameter. It is placed near the centre of the wide occipital portion of the median coronal bones. The mucus-grooves on the muzzle, too, are well developed: one passes straight across the premaxillaries in front; from either end of this, and forming with it an acute angle, another groove passes backwards for a considerable distance along the side of the muzzle.

The teeth are nearly all present in a more or less imperfect condition; mostly, however, the stumps only remain. There are three pairs of large tusks—one vomerine, two palatal. The vomerine tusks are situated about $1\frac{1}{4}$ inch behind the anterior margin of the præmaxillæ; the basal portions of these project considerably, and measure in diameter $\frac{3}{4}$ inch. The first pair of palatal tusks are placed 2 inches further back, and are scarcely so large as the vomerines; the second pair, which seem equally large, are $1\frac{1}{4}$ inch further in the rear, being somewhat in front of the transverse centre of the skull. Each præmaxilla bears four teeth, which are upwards of a $\frac{1}{4}$ inch wide at the base. There are five or six rather smaller teeth between the vomerine and the first palatal tusk, and the like number between the latter and the second palatal tusk; and behind this, again, there are four or five more, making in all in each side of the jaw about twenty teeth. All these teeth are placed a little apart, and have depressions behind them in the alveolar border; the tusks also are accompanied by similar depressions.

Not far from the spot where this fine skull was obtained, two mandibular rami (a right and a left) occurred two or three feet apart. They are of the same size, and most probably belonged to the skull in question. This would seem to be likely, not only on account of their close proximity, but also on account of their size, which agrees well with that of the cranium. The left ramus is imperfect, the posterior portion having been fractured and lost. A piece 9 inches long, however, of the anterior portion remains in a very good state, with

* Quarterly Journal of the Geological Society, 1862, vol. xviii. p. 291.

the stumps of the teeth attached. The right ramus is almost perfect; the alveolar border is quite so, and exhibits the teeth in a beautiful state of preservation; a great portion of the dentary bone is present, and is covered with the usual reticulated sculpture; the anterior extremity is quite perfect, as well as the articular bone—at the posterior end with the glenoid surface, which is transversely elongated, deep, and considerably elevated.

This large and perfect ramus is nearly $14\frac{1}{2}$ inches in length, and at the widest part, which is about 4 inches from the posterior extremity, is $2\frac{3}{4}$ inches broad. From this point it tapers gradually to the anterior end, where it is little more than an inch wide. The inferior margin is slightly convex; and the alveolar border is somewhat concave, with a slight eminence in front giving support to the first large tusk-like tooth.

There are upwards of twenty teeth, seventeen or eighteen of which are well preserved; a dozen are entire. They vary much in size, and in some places are arranged almost in contact; in other places they are considerably apart. Three are much larger than the rest, and seem to correspond to the vomerine and palatal tusks of the skull. These large teeth are $1\frac{1}{2}$ inch long, and are upwards of $\frac{1}{2}$ an inch wide at the base. The first of these is placed an inch from the anterior extremity, upon the eminence of the alveolar border already noticed; a single small tooth is situated in front of this. The second large tooth is 2 inches further back, and the third is $1\frac{1}{8}$ inch behind the second; the last is therefore $3\frac{3}{8}$ inches behind the first; but the space between the apices of the first and last large teeth is $4\frac{1}{4}$ inches—a distance corresponding very nearly to that between the depressions behind the vomerine and last palatal teeth. The smaller teeth vary from $\frac{3}{8}$ to about $\frac{3}{4}$ of an inch in length; they are all considerably compressed towards the apex, and have wide cutting-margins; the lower portion is rounded and grooved, the grooves extending for a considerable way up the crown.

Archichthys sulcidens, Hancock & Atthey.

Some additional remains of this large and powerful fish have recently occurred at Newsham, where the original specimens were obtained that were described some time ago in the 'Annals' (April 1870). The most important of these recent acquisitions is a considerable portion of a crushed head, which, though in a bad and much disturbed condition, shows in a very satisfactory manner the thick, massive character of the bones; moreover many of the parts are very well displayed. A large portion of a mandible, measuring upwards of 10 inches

long, lies in the middle of the mass, with the inner surface exposed, and with the alveolar border turned over; so that several of the teeth are seen, measuring from $\frac{3}{8}$ to $\frac{1}{2}$ inch in length. This fragment (for, large as it is, it is but a fragment) has lost both extremities.

The anterior extremity of each mandibular ramus is likewise present on the slab, and has a large laniary tooth in front, and several of the small teeth behind. One of the large teeth is nearly perfect, and measures 2 inches in length, though the extreme apex is deficient, and is nearly an inch wide at the base. The other laniary tooth has been apparently equally large, but merely its stump remains. The largest of the small teeth are about half an inch long; they appear, however, to have been pretty regular in size, and are placed a little apart from each other. These two mandibular fragments are each upwards of 2 inches long; so that if one of them be joined to the large portion of the mandible already described, we have the dimensions raised to 12 inches; but as we have no means of determining how much of the proximal extremity is wanting, it is difficult to say what was the real length of this formidable jaw when perfect. Its massiveness, however, is sufficiently evident, as the bone of the anterior fragment is nearly an inch thick.

The left præmaxilla is also very well displayed, lying across the large mandibular fragment. It is $3\frac{1}{2}$ inches long, and is $1\frac{3}{4}$ inch wide. The anterior extremity is rounded; and close to the front margin there is, as in the mandible, a laniary tooth, which is small, however, in comparison with that of the latter; it is $\frac{7}{8}$ inch in length, and is proportionately narrow. This tooth is succeeded by about twenty minute teeth, $\frac{1}{8}$ inch long, or thereabouts, which are very regularly arranged at a little distance from each other.

Mixed up with the above are many other bones, belonging apparently to the skull; but they are too much broken up to admit of exact determination; the right præmaxilla, however, with its anterior laniary tooth, can be discovered amidst the commingled mass.

The surface of the more perfect bones exhibits the peculiar tubercular sculpture originally described; and the characters of the teeth show no variation from (indeed they are precisely similar to) those at first pointed out as distinguishing the species.

Two gigantic jugular plates were obtained at the same time, associated with the above remains, though not on the identical slab. We do not hesitate to assign them to *Archichthys*, not more on account of their association than from the character

of the surface-structure, which agrees with that of the other bones of this fish, and that we know of no other species found in our coal-shales to which they can belong. The size alone would seem sufficient to determine the question. *Megalichthys* is certainly a large species; but the largest jugular plate we have seen of that fish is scarcely more than 7 inches long, not half the length of those in question. And, moreover, its form and enamelled surface are sufficient to distinguish it, though in general character it has considerable resemblance to the specimens under discussion. Except those that are altogether out of the question, the only other fishes of any considerable size that occur in our coal-shales are the three large species of *Ctenodus*: in this genus, however, the mandible is too short, and the space in front between the rami too contracted to admit of there being any large jugular plates; indeed *Ctenodus* is understood to have no jugular plates. Unfortunately, these two enormous plates are imperfect; but what remains of each is in an excellent state of preservation, and lies flattened out, the form being completely retained: and there is no difficulty in determining the entire contour; for whilst one has only the posterior extremity imperfect, this extremity in the other is entire.

The right plate has the under surface exposed; the anterior portion of this is quite perfect, a small part only of the posterior extremity, as just noticed, being wanting. In front it tapers gradually to a point, and there is a notch on the inner margin, about $1\frac{1}{4}$ inch from the apex; at this part the surface is depressed diagonally, the depression being bounded in front by a stoutish ridge. This plate, or, rather, as much of it as remains, is 12 inches long and $4\frac{1}{2}$ inches wide. Only the posterior extremity of the left plate is present; and this fragment is $3\frac{1}{2}$ inches in length, and lies with the upper surface exposed, with the inner margin in contact with the outer margin of the other plate. The posterior border is obtusely pointed; but as the slope is shorter on the outer than on the inner margin, the acumination is towards the outer edge.

By the aid of these two fragments, the form of the entire plate is easily determined. It is elliptical or widely fusiform, with the anterior extremity pretty regularly and gradually pointed, the posterior end being more abruptly and eccentrically acuminated. When perfect, these huge jugular plates cannot have been less than 14 or 15 inches in length, as, judging from the specimens, it would seem evident that the fragment (which is 12 inches long) of the right plate has lost two or three inches of its posterior extremity.

A fragment of a bone lies on the outer margin of the right

plate, which in all probability is the anterior central plate ; but it is too imperfect to admit of any decided opinion.

The bones originally supposed to be jugular plates were folded and much crumpled and distorted, so that their form and dimensions could not be determined with certainty. We are now disposed to consider these to be certain cranial bones, of the exact nature of which we have not yet satisfied ourselves.

From the size of the jugular plates a very fair estimate may be made of the magnitude of the head. In *Megalichthys* the large jugular plates (and in that genus these plates closely resemble those of *Archichthys*) are about the length of the mandible, or rather a little shorter, allowing for the projection of the rami in front. If therefore we take this as a guide, and are correct in estimating the jugulars in *Archichthys* at 14 or 15 inches, the mandible cannot have been less than 15 or 16 inches long. Now, as the head extends considerably backwards beyond the articulation of the mandible, in some species for more than a third of the length of the mandible, it would appear that the head of *Archichthys* may be estimated as about 20 inches long, including, of course, in this calculation the gill-plates. That this is not an over-estimate is evident from the fact that the operculum and præ-operculum together are between 4 and 5 inches wide. The width of the head can also be very correctly estimated: it could not be less than ten or twelve inches. This is evident when we recollect that the joint width of the jugulars is 9 inches, that the mandibular rami are each an inch thick, and that it is not improbable that there were small external jugular plates lying between the rami and the outer margins of the large jugulars.

These are formidable proportions, indicating a very powerful creature ; and when we take into account the magnitude of the oral weapons and the animal's superior activity, *Archichthys* must have been no mean rival to the large Amphibians of the Carboniferous waters: it must have been quite able to hold its own against *Loxomma*, or even against the more powerful *Anthracosaurus*.

Notwithstanding the recent discovery of this large and formidable fish, we are in possession of more information respecting it than has been attained in regard to many species that have been acknowledged for years. The characters of the dentition are perfectly determined: the mandible and præ-maxilla have been obtained in a good state of preservation, with the teeth attached. The gill- and jugular plates, too, have occurred in most excellent condition, as well as several other bones, including some that apparently belong to the thoracic

girdle. The body-scales have likewise been found associated with the bones.

We have also good reason to conclude that the genus *Archichthys* occurs not only in other coal-fields, but likewise considerably lower in the Carboniferous series.

EXPLANATION OF PLATE VI.

View of the inner surface of a portion of a mandibular ramus of *Anthracosaurus Russellii*, a little reduced in size: *a*, alveolar border; *b*, inferior margin; *c*, inner or splenial plate; *d*, outer plate or dentary bone; *e*, depression in alveolar border; *f*, elevated straight portion of ditto; *g*, impression of first tooth of the series; *h*, remains of the last ditto.

X.—*On Foraminifera from the Gulf and River St. Lawrence.*
By G. M. DAWSON*.

SEVERAL of the species of Foraminifera found in the Gulf of St. Lawrence have been noticed by Principal Dawson in vol. v. of the 'Canadian Naturalist,' p. 188 *et seq.* The following Table (pp. 88, 89), however, is the only approach to a complete view of the species and their distribution hitherto attempted.

Many of the deeper samples were small quantities of mud brought up in sounding, by Capt. Orlebar, R.N., of the Coast Survey, and by him kindly presented to Dr. Dawson.

The specimens from Labrador were obtained from material dredged by the officers of the Geological Survey; those from Prince-Edward Island were from a sample secured by C. Robb, Esq.; and those from the bank of Newfoundland were obtained from the late Sheriff Dickson, of Kingston.

The somewhat extensive series from Gaspé Bay was obtained during a dredging-expedition in the summer of 1869. The mud was sampled when brought up by the dredge, and reserved for examination, the depth being ascertained as carefully as possible. Several very rich and interesting samples are also from the dredgings of Mr. J. F. Whiteaves, F.G.S., in Gaspé and its vicinity.

The means were, unfortunately, not at hand for ascertaining the temperature of the bottom. But though there is reason to believe that the water at Gaspé Bay is somewhat warmer than the Gulf of St. Lawrence in general, the mud as it came over the boat's side felt icy cold to the hand, showing even here what a great effect the iceberg-laden arctic current has on the bottom temperature. The number of species tabulated must not in every instance be taken as a criterion of the rela-

* From the 'Canadian Naturalist,' June 1870; communicated by the Author.